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APPLICATION

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TITLE: LAMINATED FIN HEAT SINK FOR ELECTRONIC DEVICES

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LAMINATED FIN HEAT SINK FOR ELECTRONIC DEVICES

Background

This invention relates to removing heat from heat producing electronic devices such as microprocessors.

In operation, electronic devices, including microprocessors, tend to generate heat. Their performance may be adversely affected by their temperature. Thus, it is advantageous to remove heat from the integrated circuits as effectively as possible.

To this end, heat sinks are commonly attached to integrated circuit packaging. These heat sinks may include fins and integrated heat spreaders which transfer heat from the integrated circuit packaging to the heat sink.

Existing heat sinks tend to be heavy, contributing to weight of the overall electronic device. In some electronic devices, including mobile devices, overall weight is an important factor.

Thus, there is a need for ways to improve the heat transfer from electronic devices.

Brief Description of the Drawings

Figure 1 is a partial, front elevational view of one embodiment of the present invention in the course of manufacture;

Figure 2 is a partial, front elevational view of the embodiment of Figure 1 after further processing; and

Figure 3 is a perspective view of one embodiment of the present invention.

Detailed Description

Referring to Figure 1, a heat sink base 12 may be formed of copper or other heat conducting material. The base 12 may have a number of closely spaced fin receiving apertures 16. In one embodiment, the fin receiving apertures 16 may have a downwardly expanding, dovetail shape.

A heat sink fin 14b may include a metallic layer 18 and a graphite or non-metallic layer 16. The non-metallic layer 16 provides good heat transfer characteristics at relatively lower weight compared to metals. In other words, the layer 16 is lighter than the layer 18 per unit of volume. The layers 16 and 18 may be bonded together along the line 20.

In the illustrated embodiment, the layers 16 and 18 are of equal thickness. One of the layers 16 or 18 may be thicker in some embodiments.

In order to join the fin 14b to the base 12, crimping forces, indicated by the arrows A and B, may be applied in one embodiment. In other words, the heat sink fin 14b may be inserted into the slot 16. Thereafter, the two opposed sides of the base 12 are compressed together causing the

edges 17 to cut into and engage the material of the fin 14b. To this end, it may be advantageous, in some embodiments, that the material of the base 12 is harder than the material used for the layer 16 or 18.

Referring to Figure 2, the completed structure may include a fin 14a engaged in a dovetail arrangement in the base 12. Indentations 19 may be formed in the fin 14a caused by the base material 12 crimping process.

The fins 14 may be made of a high conductivity metal and a pyrolytic graphite material in some embodiments. The two material sheets may be compressed together and held in place with a high thermal conductivity adhesive along the bond line 20 to form a laminated fin 14. The laminated fin 14 may then be permanently attached to the heat sink base 12, for example, using the crimping process illustrated in Figures 1 and 2. The laminated fin 14 is used in place of the traditional solid metal fin, achieving improved thermal performance and reduction in weight in some embodiments.

The metal layer 18 provides structural integrity to the laminated fin 14. An isotropic metal layer 18 may also act as a medium to transfer heat to the surrounding air via forced convection, as one example. In one embodiment, the layer 18 may be aluminum.

The layer 16, which may be graphite, may spread the heat in a more efficient manner than metal since layer 16 may have a thermal conductivity value on the order of three

times that of solid metals. Since graphite material is non-isotropic, thermal conductivity in one direction is significantly lower than in the other two directions of heat transfer. As a result, heat may be transferred effectively in the direction of the fin height and length, but not so in the direction of fin thickness. However, this is insignificant since the heat can still easily be transferred through the relatively thin fin thickness.

The layer 16 may be in intimate contact with the base 12 to improve the heat transfer through the laminated fin 14. To this end, the laminate fin 14 may be permanently attached to the base 12.

In some embodiments of the present invention, graphite material with advantageous heat transfer properties can be used in a fin shape having relatively extended aspect ratios. Normally, graphite material would not be sufficiently tough to be used in such environments. However, the combination of graphite and metal has both advantageous heat transfer properties and sufficient structural integrity.

Referring to Figure 3, the heat sink fins 14 may be attached to a base 12 so that a large number of fins are arranged in close proximity. The fins 14 may be rectangular in shape, in one embodiment, with the long axis extending along and into the base 12. An electronic device 20, such as a microprocessor, may be thermally coupled to

the base 12. In some embodiments, thermal interface materials may be utilized between the device 20 and the base 12. In addition, an integral heat spreader may be applied between the electronic device 20 and the base 12. In some embodiments, the electronic device 20 may consist of an integrated circuit enclosed within an integrated heat spreader.

In one embodiment of the present invention, the aspect (height to thickness) ratio of the fins 14 may be higher than 20:1. In one particularly advantageous embodiment, the aspect ratio may be 60:1.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is: